

# NASA TECH BRIEF

## Goddard Space Flight Center

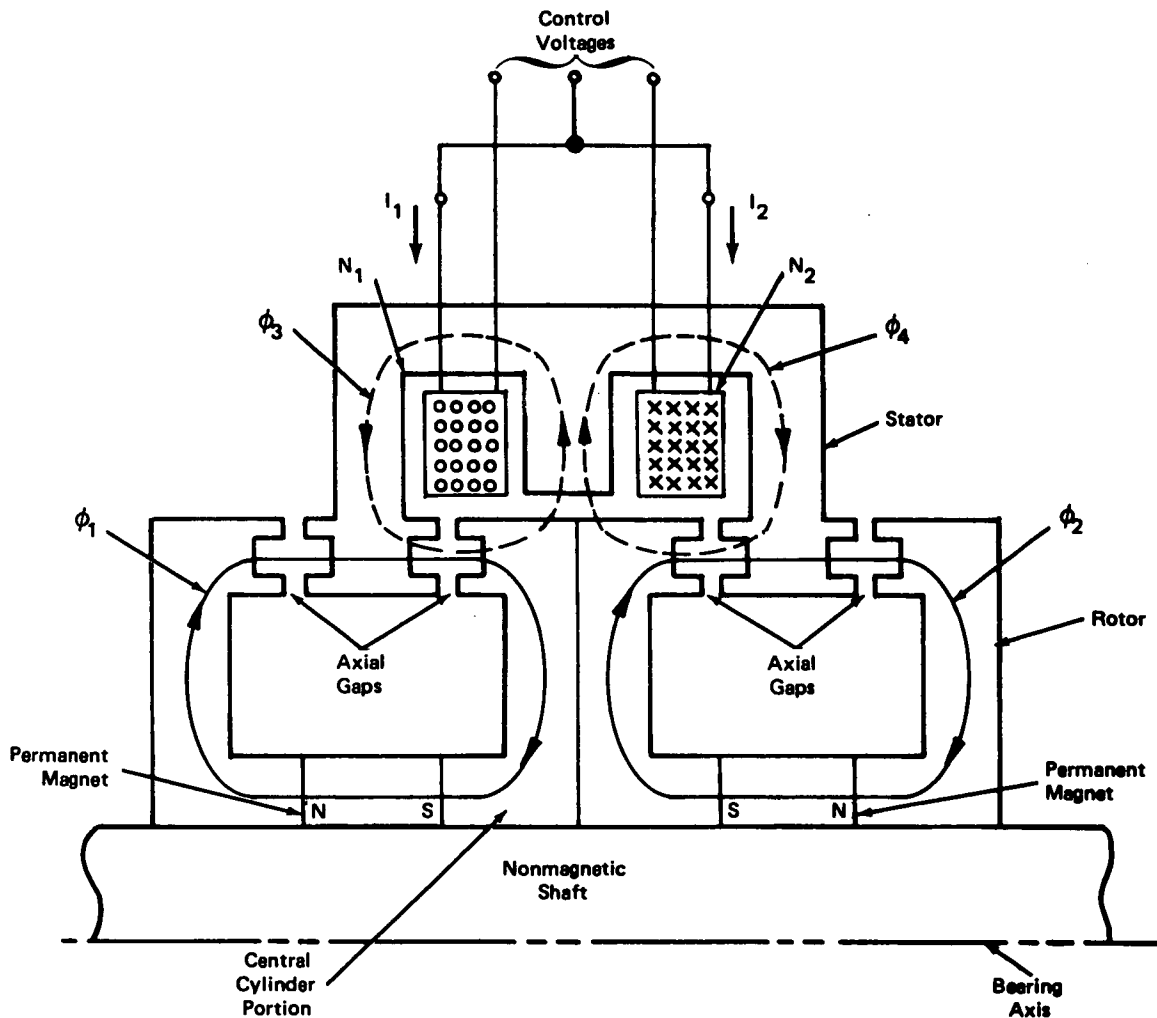


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### Magnetic Bearings with Combined Radial and Axial Control

Large spinning structures such as large electrical motors and generators develop significant frictional forces in the bearings located between rotating members. These forces cause bearings to wear rapidly, increasing the frequency and cost of maintenance. As a solution to this problem, magnetic bearings have been developed

which reduce friction by allowing air or vacuum gaps between the rotating members through properly-applied magnetic fields. The simplest designs use active axial control and passive radial alignment. A new magnetic bearing permits both axial and radial control in a relatively simple structure.



Magnetic Bearing (One Half Shown)

(continued overleaf)

The magnetic bearing as shown in the illustration separates a radially-overlapping outer stator and an inner rotor. Under no load the stator and the rotor are held coaxially aligned with each other and with the bearing axis. Radial and axial forces between stator and rotor are controlled by magnetic forces concentrated in four axial gaps. These gaps are located between the interleaved portions of the rotor and the stator.

Four magnetic circuits are included in the bearing to produce four flux paths,  $\phi_1$  through  $\phi_4$ , which cross the axial gaps. Two of these circuits comprise two aligned permanent magnets, providing oppositely-directed flux paths  $\phi_1$  and  $\phi_2$ . The other two fields,  $\phi_3$  and  $\phi_4$ , are provided by a pair of coils,  $N_1$  and  $N_2$ . The coils are driven simultaneously with pulse-width-modulated current pulse trains  $I_1$  and  $I_2$  in response to axial-force and radial-stiffness commands.

When the rotor is radially displaced from the stator by some disturbing force, the reluctance of flux paths  $\phi_1$  and  $\phi_2$  increases, which tends to decrease their magnitude. A circuit feeding coils  $N_1$  and  $N_2$  is used to determine the proper current pulse widths to either increase or decrease the bearing radial stiffness. The sum of the pulse widths of  $I_1$  and  $I_2$  produces flux magnitudes in  $\phi_3$  and  $\phi_4$  to produce the increased stiffness. Axial control is accomplished in a similar way; however, the axially restoring force between the rotor and the stator is determined from the difference in the current pulse widths.

Other important advantages of magnetic bearings are:

1. There is no physical contact between the rotor and the support structure.
2. The bearings can operate directly in the vacuum environment without lubrication.
3. There is virtually unlimited operating lifetime, independent of speed.

**Note:**

Requests for further information may be directed to:  
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Reference: TSP74-10131

**Patent status:**

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

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